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EP 0613658 A1 **WO 2003/105704 A1**
US 6200316 B1 **US 20020193801 A1**

(58) Field of Search:
UK CL (Edition X) **A5R**
INT CL[7] **A61B, A61F**
Other:

(54) Abstract Title: **A surgical guide jig with an expanding spherical joint**

(57) A surgical instrument 2 comprises a jig 4, suitable to be fixed to a bone, a support element 6 is mounted within the jig 4 and a cutting guide 8 is received within the support element 6. The support element 6 has a substantially spherical head 52, which articulates with the jig 4 and expands to lock the support element 6 in place within the jig 4. The cutting guide 8 may be a tube received within a bore of the support element 6.

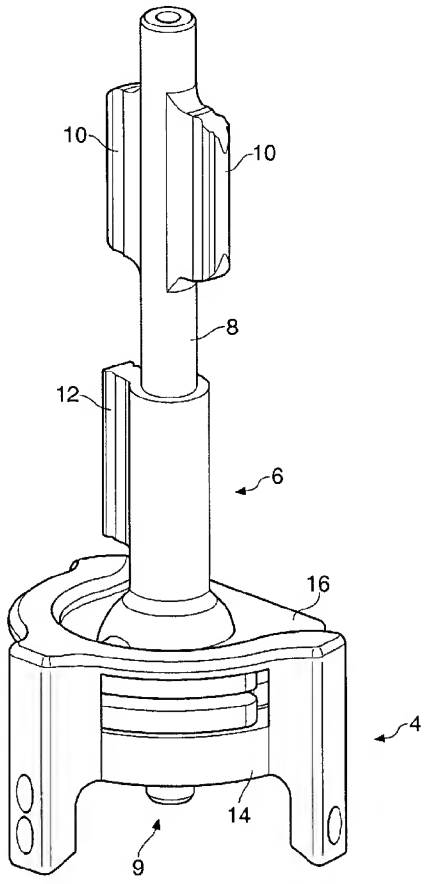

Fig. 1

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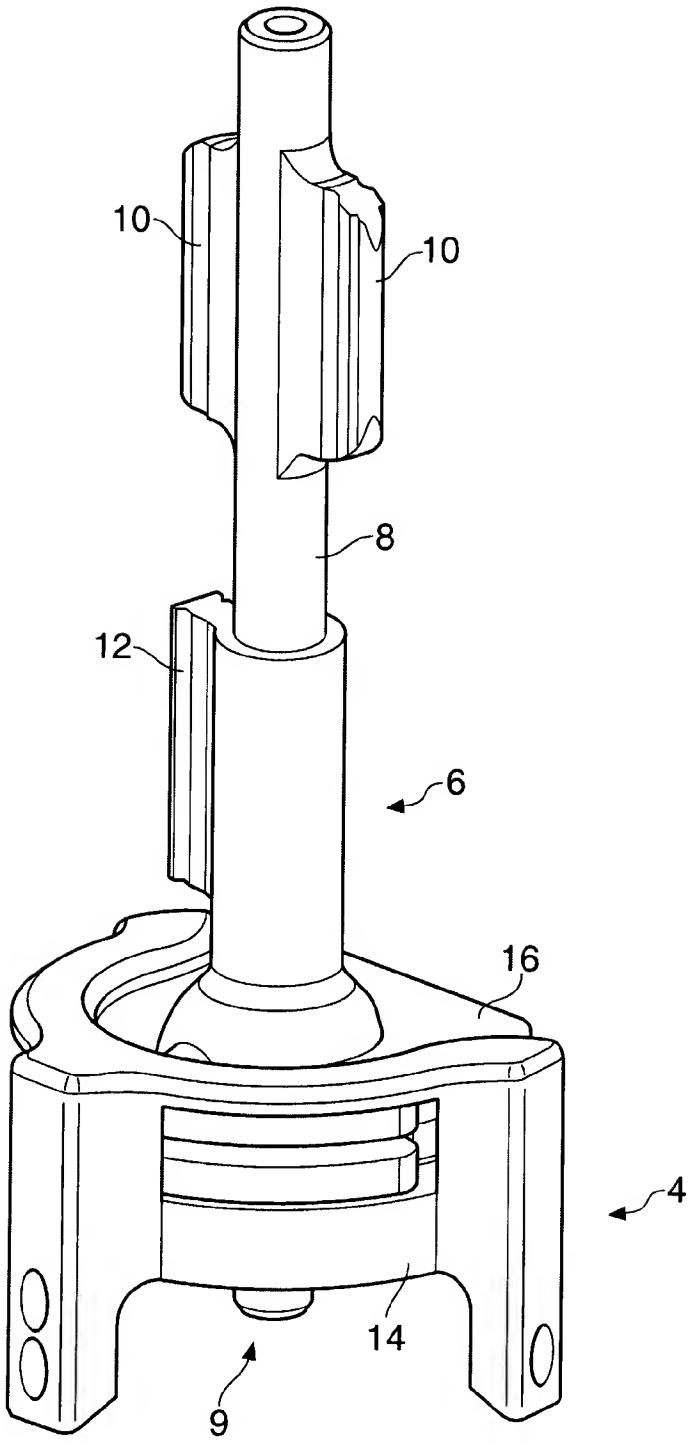

Fig. 1

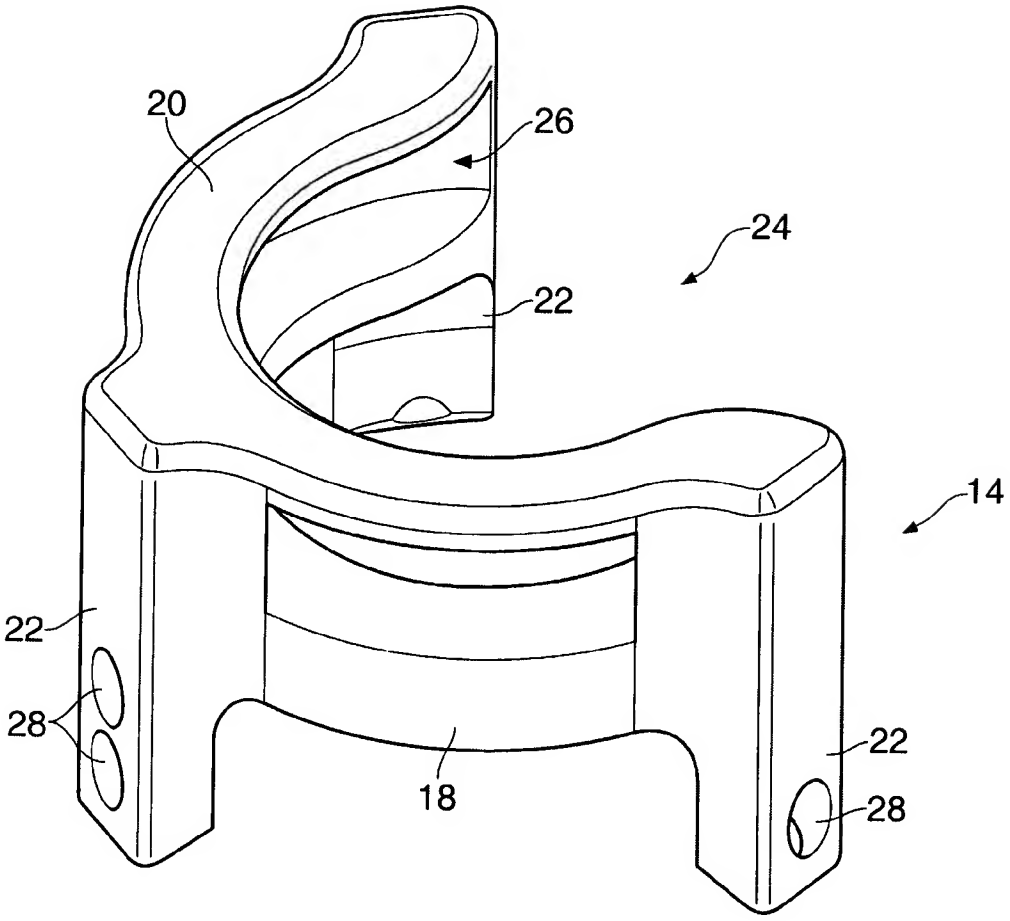

Fig. 2

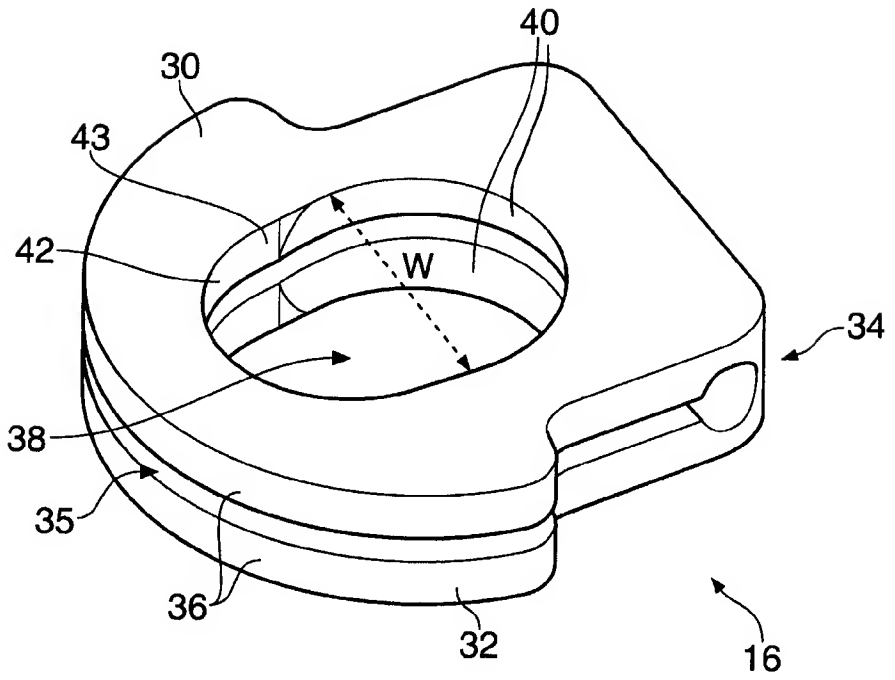

Fig. 3

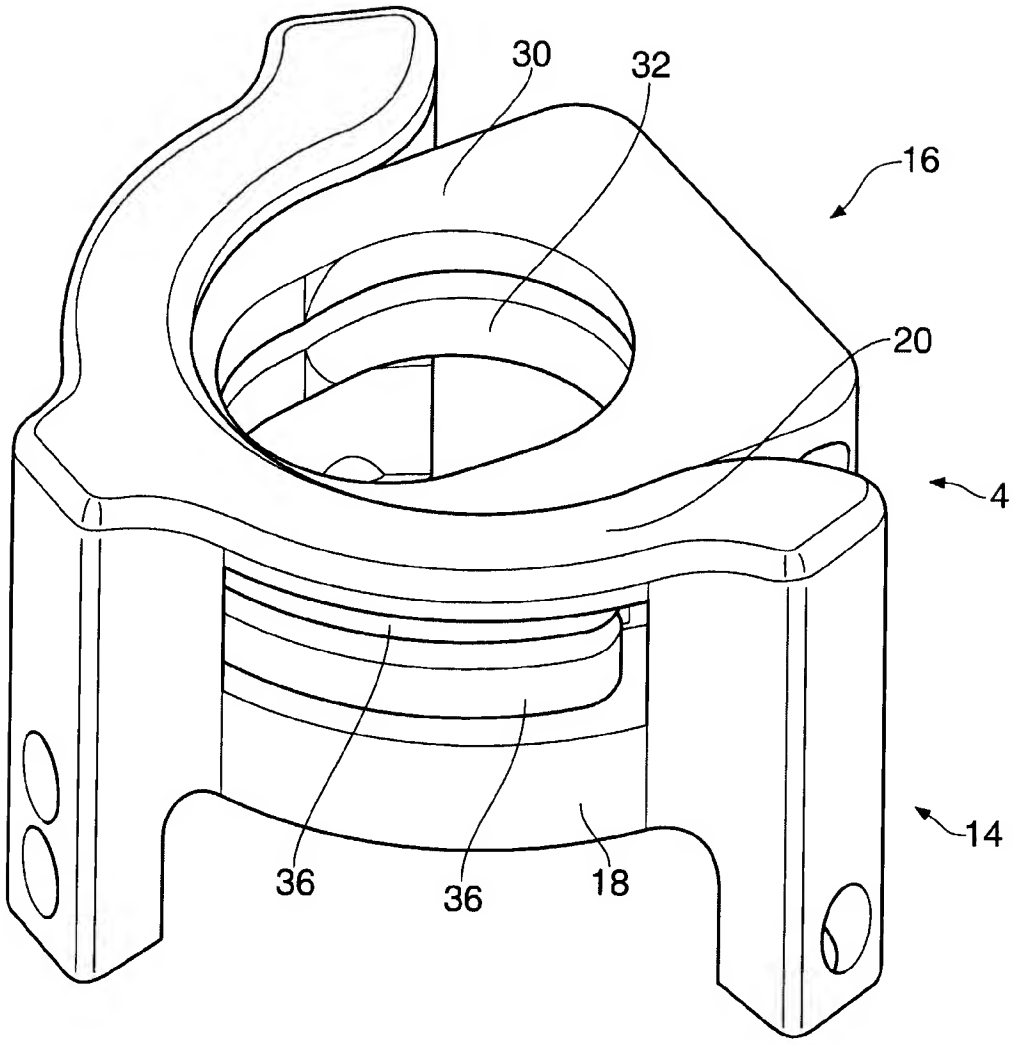

Fig. 4

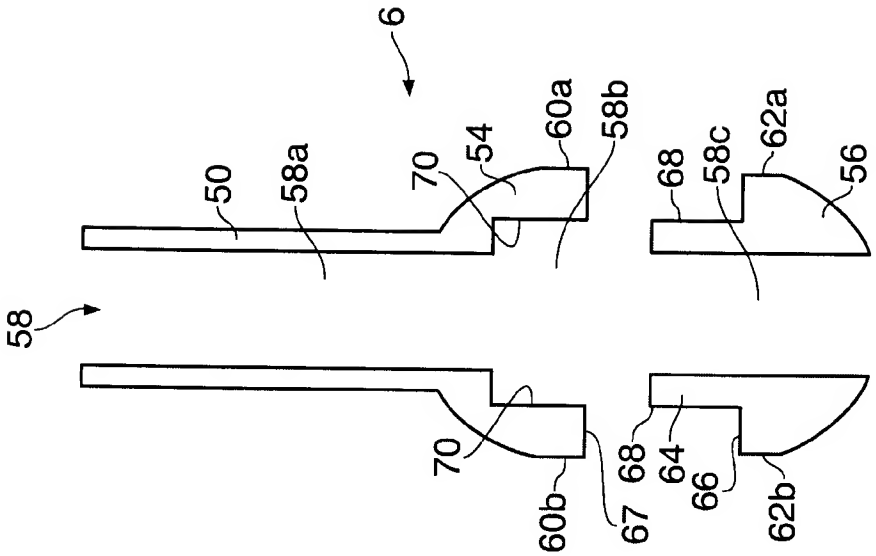
6
58
50
58a
70
54
60a
58b
68
58c
62a
56
70
60b
67
68
64
66
62b

Fig. 6

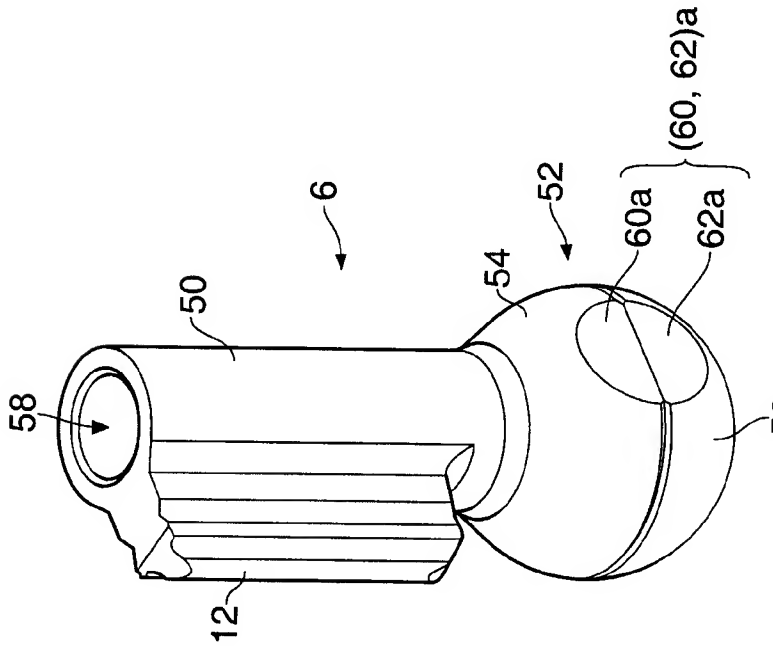
6
58
50
54
52
(60, 62)a
60a
62a
56
12

Fig. 5

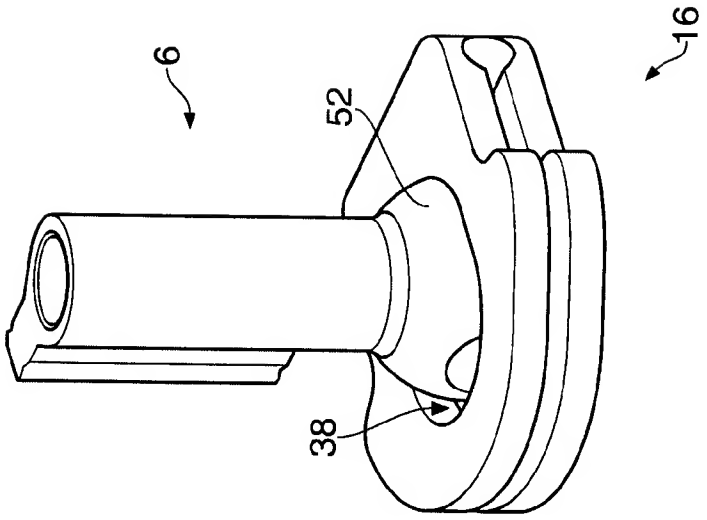

Fig. 8

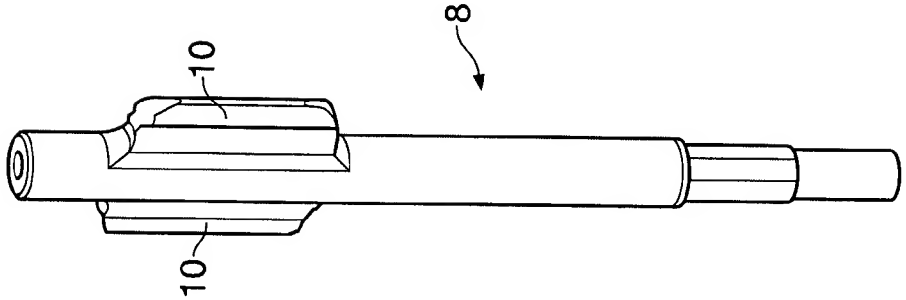

Fig. 7

SURGICAL INSTRUMENT

BACKGROUND

During all types of joint replacement surgery, and in many other surgical procedures, it is necessary to make specific cuts into areas of bone. Both the point and angle of entry of the cut is important. This is particularly so in the case, for example, of femoral head resurfacing, where it is necessary to drill a pilot hole that enters the femoral head at a specific location and passes through the centre of the femoral neck. Guide tools exist to aid surgeons in the placement of bone cuts. Such tools are often difficult and time consuming to operate, and are inaccurate. Many of the tools of the prior art are also bulky, requiring the removal or displacement of large areas of soft tissue in order to be used.

Guidance as to the point and angle of entry of a cut is conventionally provided by separate functions of a tool or by separate tools altogether. Often, guidance is only provided for one aspect of the cut. For example, the point of entry may be indicated but the angle of entry may be left to the skill and judgement of the surgeon.

SUMMARY OF INVENTION

According to the present invention, there is provided a surgical instrument comprising a jig, suitable to be fixed to a bone, a support element mounted within the jig and a cutting guide received within the support element, wherein the support element has a substantially spherical head, which articulates with the jig and expands to lock the support element in place.

The support element may have a body portion, which is connected to the head and extends away from the jig. A bore may extend through the body portion and the head of the support element. The cutting guide may be of tubular form and may be received within the bore of the support element.

The head of the support element may comprise two, substantially hemispherical elements; a fixed element, connected to the body portion and a locking element connected to the fixed element. The locking element may be connected to the fixed

element via a thread, which may be an internal thread on the bore through the fixed element.

An annular protrusion may extend from a face of the locking element towards the fixed element. The annular protrusion may have an external thread, suitable for cooperation with the internal thread on the fixed element.

A first end of the cutting guide may have an external cross section in the form of a polygon. The bore through the locking element may have an internal cross section in the form of a polygon. The external cross section of the first end of the cutting guide corresponds to the internal cross section of the bore through the locking element.

Tabs may extend from the support element and the cutting guide.

The jig may comprise a base and a lockable slide element which engages with the base, and which, in an unlocked state, is able to move relative to the base. The base may comprise two substantially U shaped, spaced apart flanges supported on at least three legs. Alternatively, the base may comprise a block having integrally formed U shaped flanges. The flanges may be substantially parallel.

The slide element may be received between the flanges of the base, and the slide element may comprise a pair of spaced apart plates. The plates may be connected at a first end only.

Each of the locking element and the fixed element may comprise at least one partially flat surface. The flat surfaces may be disposed to be adjacent one another when the threaded connection between the fixed element and the locking element is fully engaged.

The central opening in the slide element may be shaped such that the head of the support element can only be admitted when the fixed element and the locking element are fully engaged.

According to another aspect of the present invention, there is provided a method of guiding a cutting tool using the instrument of the current invention, the method comprising the steps of:

(a) mounting the support element within the jig,
(b) inserting the cutting guide within the support element,
(c) attaching the jig to a bone,
(d) articulating the support element within the jig to achieve a desired position,
(e) rotating the cutting guide relative to the support element such that the head expands and locks the support element in a fixed position relative to the jig, and
(f) inserting a cutting tool through the cutting guide to engage the bone.

Step (a) may include inserting the head of the support element within the slide element of the jig and inserting the slide element into the base of the jig. Step (d) may include translating the slide element within the jig in a plane that is defined by the flanges of the base and is broadly tangential to the bone surface beneath it, and rotating the support element within the slide element. Step (e) may include the step of forcing the plates of the slide element apart with the expanding head of the support element, such that the plates frictionally engage respective flanges of the base.

The instrument of the current invention may be stored in a container in which the slide element and support element are held in a predetermined position, in which the side element and support element are in the middle of their ranges of adjustment. In this manner, the instrument may be maintained in a position in which it is ready for use.

According to another aspect of the present invention, there is provided a joint comprising a ball and a socket, wherein the ball may be expanded via a key, thereby locking the joint. Preferably, the socket comprises a jig as disclosed above. Preferably, the ball comprises a support element as described above. Preferably the key comprises a cutting guide as described above.

According to another aspect of the present invention, there is provided an instrument comprising a base, a slide element which is adapted to slide in a predetermined plane within the base, and a locking element, the slide element including at least two parallel plates which are received within the base, wherein the plates of the slide element may be forced apart by the locking element, into frictional engagement with the base, thereby locking the slide element relative to the base.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a perspective view of a surgical instrument,

Figure 2 is a perspective view of a base of the instrument of Figure 1,

Figure 3 is a perspective view of a slide element of the instrument of Figure 1,

Figure 4 is a perspective view of a jig of the instrument of Figure 1,

Figure 5 is a perspective view of a support element of the instrument of Figure 1,

Figure 6 is a an exploded vertical sectional view of the support element of Figure 5,

Figure 7 is a perspective view of a cutting guide of the instrument of Figure 1,

Figure 8 is a perspective view of the support element of Figure 5 seated in the slide element of Figure 3.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to Figure 1, a surgical instrument 2 comprises a jig 4, in which is received a support element 6. A tubular cutting guide 8 extends through the support element 6. Tabs 10 extend from opposite sides of the cutting guide 8 and a tab 12 extends from a side of the support element 6. The jig 4 comprises a base 14 and a slide element 16, which is received within the base 14.

Referring to Figure 2, the base 14 comprises two substantially U shaped horizontal flanges 18 and 20 supported on three legs 22. The legs 22 are connected to the flanges at each end of each flange and at the midsections, thereby defining an opening 24. The flanges 18 and 20 are supported by the legs in a parallel arrangement one above the other, thus defining an inter-flange space 26. At least one passage 28

extends through each leg 22 in the lower region of the leg. Each passage 28 extends through a respective leg 22 at an angle of approximately 45° to a longitudinal axis of the leg.

Referring to Figure 3, the slide element 16 comprises upper and lower parallel plates 30 and 32, which are joined at one edge by a live hinge 34 and define an inter-plate space 35. The edge of each plate 30, 32 that is remote from the hinge 34 defines an arcuate surface 36. Openings 38 extend through a central region of each plate 30, 32. Each opening 38 comprises two overlapping circular holes of different diameters formed through the respective plate 30, 32. The larger hole 40 defines an articulation region in which the support element 6 is received. Larger hole 40 tapers radially inwardly as it extends away from the inter-plate space 35. The smaller hole 42 defines a region of free play. An internal wall 43 of the smaller hole 42 is perpendicular to faces of the plates 30,32.

Referring to Figures 5 and 6, the support element 6 comprises a tubular main body 50 and a substantially spherical head 52. A bore 58 extends through the main body 50 and head 52 of the support element 6. The head 52 comprises a fixed section 54, which is integral with the main body 50, and a locking section 56, which is connected to the fixed section 54 via a thread. An annular protrusion 64, having an external thread 68, extends from a face 66 of the locking element 56 and is received within the fixed element 54.

The bore 58 comprises a main body bore 58a, a fixed element bore 58b and a locking element bore 58c. The main body bore 58a is of circular cross section and constant diameter. The fixed element bore 58b is also of circular cross section but is of greater diameter than the main body bore 58a. The fixed element bore 58b includes an internal thread 70 and receives the annular protrusion 64 of the locking element 56. The locking element bore 58c is of hexagonal cross section and has a diameter that is smaller than that of the main body bore 58a.

Flat surfaces 60a and 60b are formed on opposite sides of the substantially hemispherical outer surface of the fixed element 54. Consequently, the diameter of fixed element 54 is reduced in the region between the flat surfaces 60a and 60b. Similar flat surfaces 62a and 62b are formed on opposite sides of the outer surface of

the locking element 56. Consequently, the diameter of the locking element 56 is similarly reduced in the region between flat surfaces 62a and 62b.

Referring to Figure 7, the cutting guide is of substantially circular outer cross section along the majority of its length. A first, lower end 9 of the cutting guide 8 has a hexagonal outer cross section.

Referring to Figure 4, in order to assemble the jig 4, the slide element 16 is received within the inter-flange space 26 of the base 14. The arcuate surfaces 36 of the plates 30 and 32 are received between the flanges 18 and 20 such that the openings 38 are disposed within the centre of the opening 24 and the hinge 34 is opposite the central leg 22 of the base 14.

Referring to Figure 5, the annular protrusion 64 of the support element 6 is screwed into the fixed element bore 58b, with the face 66 of the locking element 56 in contact with a lower face 67 of the fixed element 54. In this assembled state, the main body bore 58a is adjacent to and continuous with the locking element bore 58c, thus forming the bore 58. Furthermore, each of the flat surfaces 60a and 60b is adjacent to a corresponding flat surface 62a and 62b, forming two pairs of flat surfaces (60,62)a and (60,62)b. Thus the diameter of the head 52 is reduced in the region between the pairs of flat surfaces (60,62)a and (60,62)b. Rotation of the locking element 56 relative to the fixed element 54 and main body 50 causes each pair of flat surfaces (60,62)a and (60,62)b to be moved out of alignment. Further, the action of the cooperating threads 68 and 70 causes the locking element 56 to translate away from the fixed element 54.

Referring to Figure 1, the tubular cutting guide 8 is received within the bore 58 that passes through the support element 6. The hexagonal lower end 9 of the cutting guide 8 is received within the locking element bore 58c and acts a key, by which the locking element 56 may be rotated relative to the main body 50 and fixed element 54 of the support element 6, without the need for direct contact with the locking element 56.

Referring to Figures 3 and 8, the head 52 of the support element 6 is received through one of the openings 38 that extend through the slide element 16. The diameter of the smaller hole 42, which defines the region of free play of a respective opening 38, is less than that of the head 52. The walls of larger hole 40, which defines the articulation region of a respective opening 38, taper so that the smallest diameter part of larger

hole 40, which is at the entry to opening 38, is also less than the diameter of the head 52. Consequently, in order to pass into the opening 38, the head 52 must be fully assembled and oriented such that the reduced diameter region of the head 52, between the pairs of flat surfaces (60,62)a and (60,62)b, extends across the width (W) of opening 38 in the region where smaller hole 42 and larger hole 40 overlap. Once the widest part of head 52 has passed into the opening 38, the head 52 is in a position partially occupying the region of free play. The head 52 is then displaced towards the tapered walls of larger hole 40 to fully occupy the articulation region of the opening 38.

Once contained within the articulation region, the head 52 is free to rotate, constrained by the taper of the walls of larger hole 40 and the presence of the main body 50

When it is desired to remove the head 52 from the opening 38, the head is again oriented such that the reduced diameter region of the head 52, between the pairs of flat surfaces (60,62)a and (60,62)b, extends across the width (W) of opening 38. In this orientation, the head 52 may be displaced towards smaller hole 42, partially entering the region of free play. The head 52 may then be removed from the opening 38.

Prior to an operation, the instrument 2 is assembled into the configuration shown in Figure 1 by positioning the slide element 16 between the flanges 18 and 20 of the base 14, inserting the head 52 of the support element 6 into the articulation region 40 of the opening 38 in the slide element 16 and inserting the cutting guide 8 into the bore 58 that extends through the support element 6. The base 14 can then be attached to a surface through which it is desired to cut. This surface may be the surface of a human femoral head. The base 14 is attached to the surface via screws (not shown), which pass through passages 28 in legs 22. The slide element is translated within its horizontal plane until a desired position within that plane is reached. The head 52 is rotated within the slide element 16 until a desired angle of the cutting guide 8 is reached. Once the cutting guide 8 is in the desired position, the instrument 2 is locked by rotating the cutting guide 8 relative to the main body 50 of the support element 6 using tabs 10 and 12. This rotation causes the locking element 56 of the head 52 to rotate relative to the fixed element 56. The action of the cooperating threads 68 and 70 causes the locking element 56 to translate away from the fixed element 54 and thus causes the head 52 to expand. The expanded head 52 forces the plates 30 and 32 of the slide element away from one another and thus into frictional engagement with the flanges 18 and 20 of the base. The head 52 and slide element 16 are thus locked in

position relative to the base 14. A cutting tool such as a drill (not shown) may then be inserted into the cutting guide 8 to perform the necessary cut.

CLAIMS

1 A surgical instrument comprising a jig, suitable to be fixed to a bone, a support element mounted within the jig and a cutting guide received within the support element, wherein the support element has a substantially spherical head, which articulates with the jig and expands to lock the support element in place within the jig.

2 A surgical instrument as claimed in claim 1, wherein the support element has a body portion, which is connected to the head and extends away from the jig.

3 A surgical instrument as claimed in claim 2, wherein a bore extends through the body portion and the head of the support element.

4 A surgical instrument as claimed in claim 3, wherein the cutting guide is of tubular form and is received within the bore of the support element.

5 A surgical instrument as claimed in any one of claims 2 to 4, wherein the head of the support element comprises two substantially hemispherical elements, a fixed element, connected to the body portion and a locking element connected to the fixed element.

6 A surgical instrument as claimed in claim 5, wherein the locking element is connected to the fixed element via a thread such that rotation of the locking element causes the locking element to move away from the fixed element.

7 A surgical instrument as claimed in claim 6, wherein the bore through the fixed element has an internal thread.

8 A surgical instrument as claimed in claim 6 or 7, wherein an annular protrusion extends from a face of the locking element towards the fixed element.

9 A surgical instrument as claimed in claim 8, wherein the annular protrusion has an external thread, suitable for cooperation with the internal thread on the fixed element.

10 A surgical instrument as claimed in any one of the preceding claims, wherein a first end of the cutting guide has an external cross section in the form of a polygon.

11 A surgical instrument as claimed in any one of claims 5 to 10, wherein the bore through the locking element has an internal cross section in the form of a polygon.

12 A surgical instrument as claimed in claim 11, wherein the external cross section of the first end of the cutting guide corresponds to the internal cross section of the bore through the locking element such that rotation of the cutting guide causes rotation of the locking element relative to the fixed element.

13 A surgical instrument as claimed in any one of the preceding claims, wherein tabs extend from the support element and the cutting guide.

14 A surgical instrument as claimed in any one of the preceding claims, wherein the jig comprises a base and a lockable slide element which engages with the base, and which, in an unlocked state, is able to move relative to the base.

15 A surgical instrument as claimed in claim 14, wherein the base comprises two substantially U shaped, spaced apart flanges supported on at least three legs.

16 A surgical instrument as claimed in claim 15, wherein the flanges are substantially parallel.

17 A surgical instrument as claimed in any one of claims 14 to 16, wherein the slide element is received between the flanges of the base.

18 A surgical instrument as claimed in any one of claims 14 to 17, wherein the slide element comprises a pair of spaced apart plates.

19 A surgical instrument as claimed in claim 18, wherein the plates are connected at a first end only.

20 A surgical instrument as claimed in any one of claims 14 to 19, wherein the slide element comprises a central opening for receiving the head of the support element.

21 A surgical instrument as claimed in any one of the preceding claims, wherein each of the locking element and the fixed element comprises at least one partially flat surface.

22 A surgical instrument as claimed in claim 21, wherein the central opening in the slide element is shaped such that the head of the support element can only be admitted when the flat surfaces are disposed to be adjacent one another.

23 A surgical instrument substantially as described herein with reference to and as shown in the accompanying drawings.

Application No: GB0503137.2 **Examiner:** Mr Alex Robinson

Claims searched: 1 to 22 **Date of search:** 26 May 2005

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X,Y	X: 1 to 4, Y : 1 to 5.	US6200316 B1 (Zwirkoski) Whole document.
Y	1 to 5	US2002/0193801 A1 (Marchione) Whole document.
Y	1 to 5	EP 0613658 A1 (Protek) Figures and abstracts, WPI Abstract Accession No.:1994-272782
Y	1 to 5	WO 03/105704 A1 (Smith and Nephew) See in particular figures 4 and 5.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

A5R

Worldwide search of patent documents classified in the following areas of the IPC^{07}

A61B; A61F

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI.